THE LINUX FOUNDATION

OPEN SOURCE SUMMIT INDIA

The Next Evolution of Java: ☕ Achieving Hyper Performance and Efficiency in Cloud Native Workloads

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  - Cloud Native Runtimes
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- Microsoft MVP - Java & Developer Tools
- Keynote Speaker & Published Author
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Why Java on Kubernetes Needs Tuning

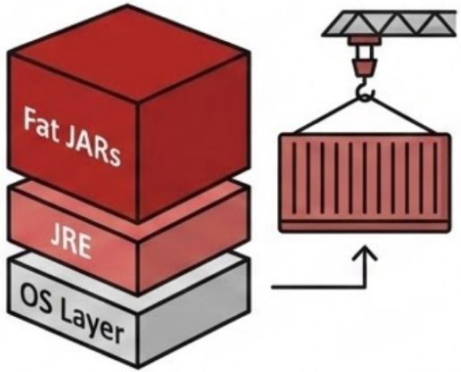
The Problem: Java is powerful, but Kubernetes exposes its traditional weaknesses:

Slow Startup (Cold Start)

Traditional JVM startup: seconds to tens of seconds.

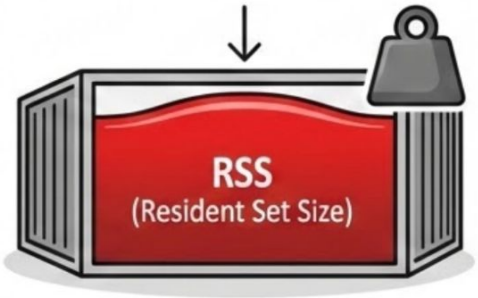
The JVM needs time to warm up (JIT compilation, class loading).

Large Container Images



Fat JARs + OS layer + JRE = huge download/deploy times.

Memory Consumption



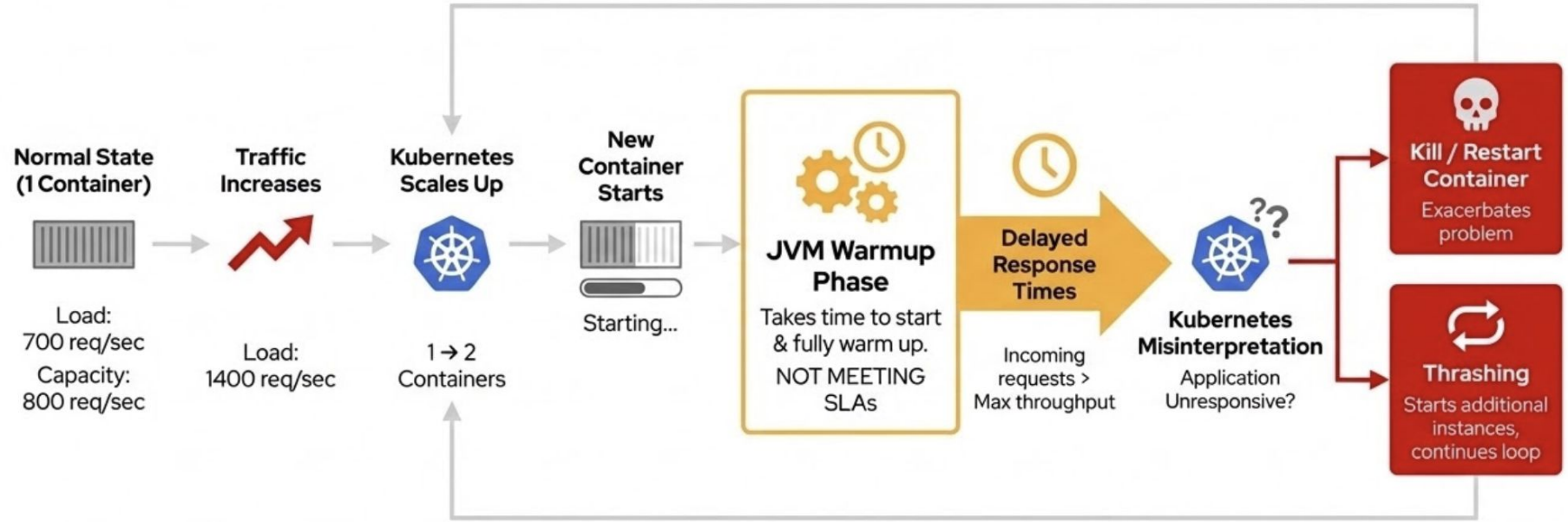
Memory overhead (JVM + libraries).

High RSS due to large JRE overhead.

Container resource limits add pressure.

Java wasn't initially Cgroup aware. Cost & efficiency matter at scale.

JVM Scaling in Kubernetes



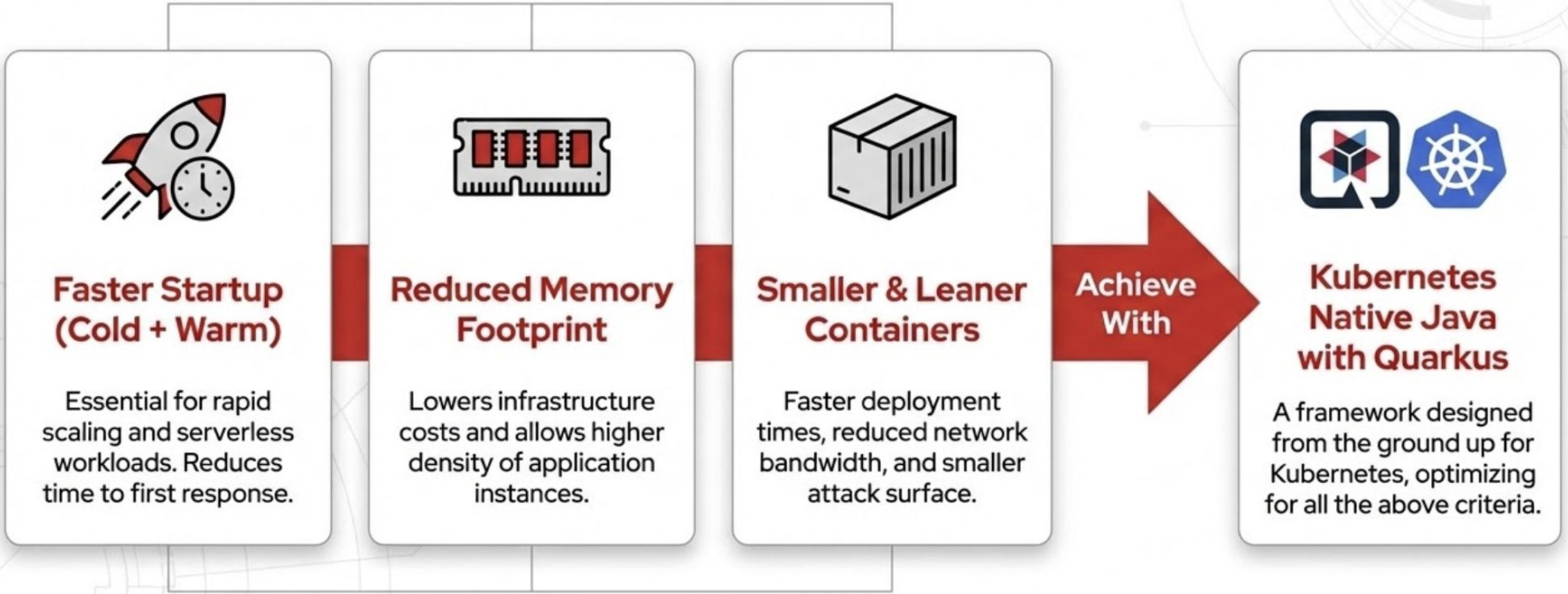
Customer Story: Vodafone Greece

Spring Boot misbehaved under load, K8s exacerbated. Solved by moving to Quarkus.

Note on startupProbe: Useful, but doesn't resolve performance issues.

Performance Goals

Success Criteria for Java in Containerized Environments:



Toolchain Overview

Introduce the tools—each solves different parts of the problem.

Jib

Build lean images, no Dockerfile required

GraalVM Native Image

Faster startup and lower footprint

CDS (Class Data Sharing)

Faster JVM startup

CRaC (Coordinated Restore at Checkpoint)

Snapshot JVM state for near-instant recovery

Leyden

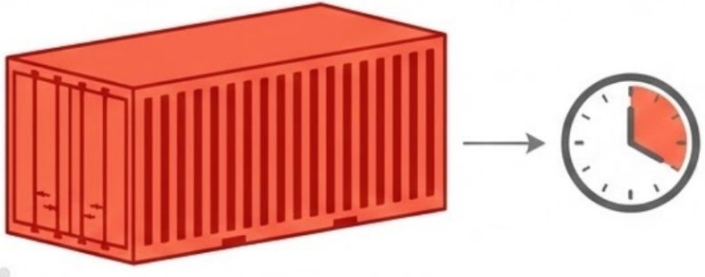
JVM-level improvements to startup and footprint

Quarkus

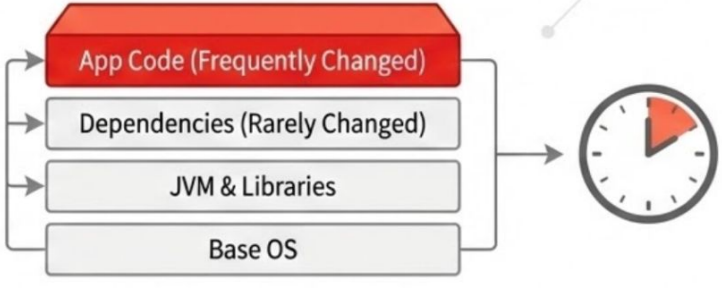
Kubernetes native Java framework

Jib – Lean Container Images

Why Smaller, Layered Images Matter for Faster Kubernetes Rollouts



Traditional Monolithic Image
(Slow Updates)



Jib Layered Image
(Fast Updates)

Smart Layering & Caching

Dependencies and application code are separated. Only the changed layer is rebuilt and pushed, drastically reducing build and deployment times.

Direct Build Integration

Builds directly from Maven or Gradle plugins. No Dockerfile is required, simplifying the project structure.

Daemonless & Secure

No local Docker daemon is needed. This improves security and is ideal for CI/CD environments without privileged access.

Simple Command

Build and push with a single command:

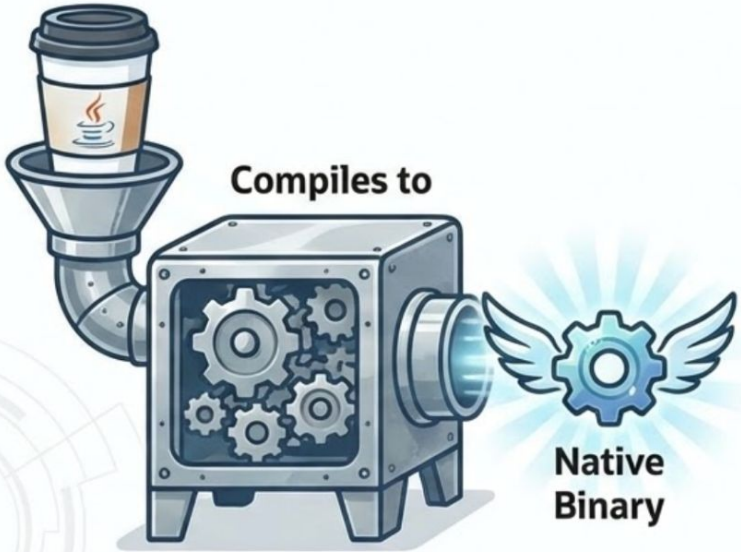
```
mvn compile jib:build
```

Jib

Containerize your Java application.

GraalVM Native Image

Realistic expectations—native image is not a silver bullet.



Benefits

- Fast startup (milliseconds vs. seconds)
- Lower memory usage

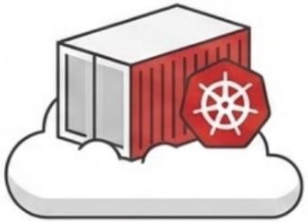
Trade-offs

- Longer build time
- Limited reflection/dynamic class loading support

GraalVM

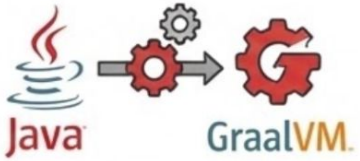
Quarkus – Framework Level Optimizations

Kubernetes Native



Built for Kubernetes & container-first workloads.

GraalVM Support

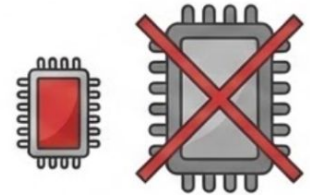


Native image support via GraalVM.

Dev Mode & Rebuilds

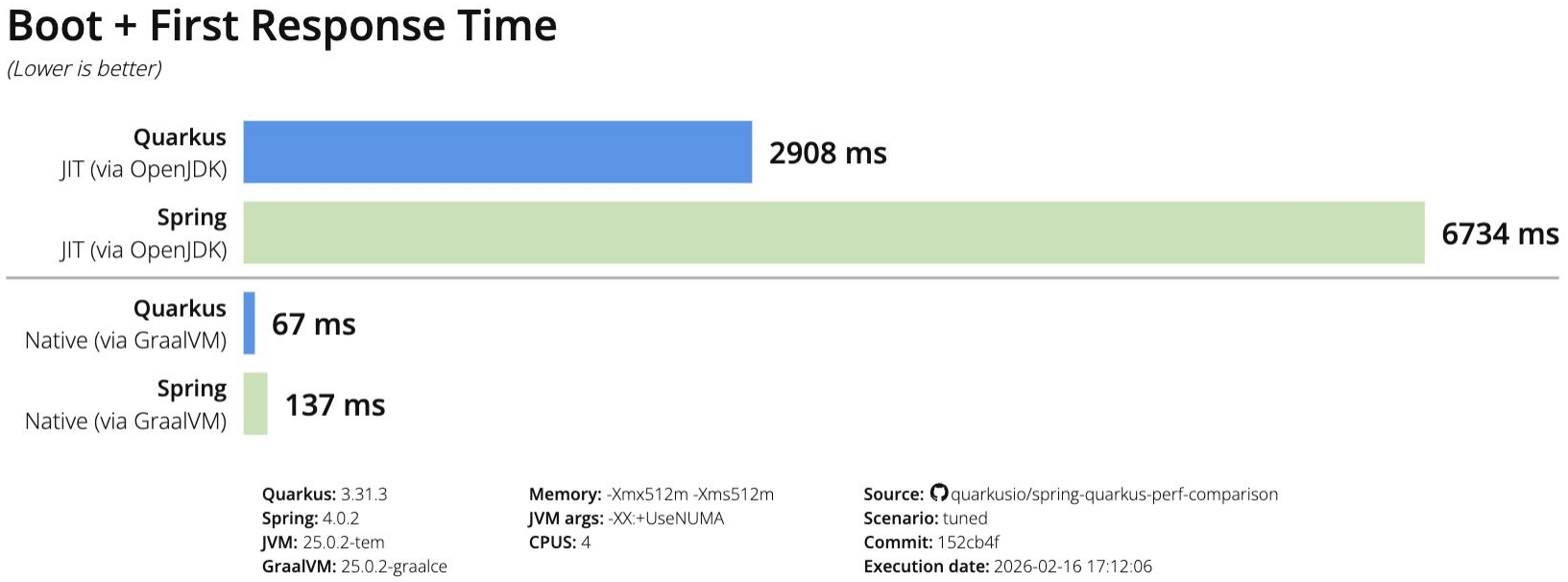
Dev mode & fast rebuilds.

Low Memory Footprint



Lower memory footprint than traditional Java stacks.

Quarkus offers unequaled performance I

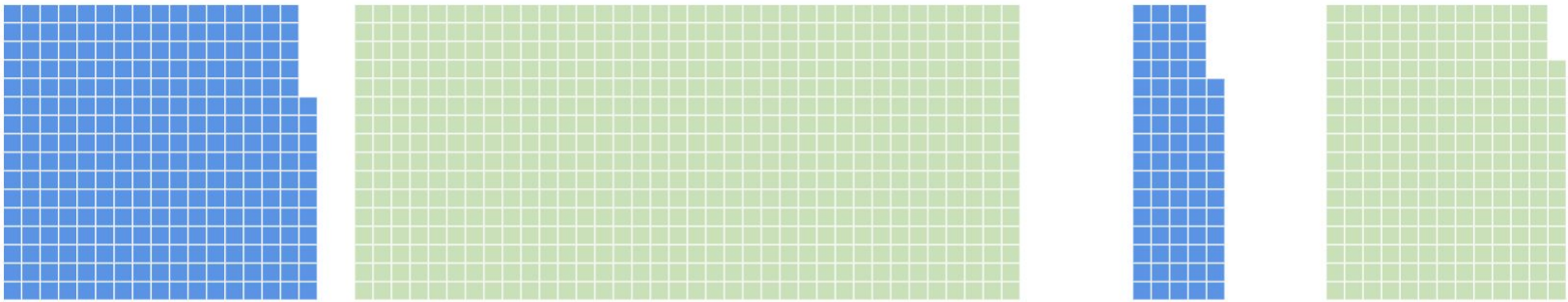


https://github.com/quarkusio/benchmarks

Quarkus offers unequaled performance II

Memory (RSS after first request)

(Smaller is better)



Quarkus
JIT (via OpenJDK)
267 MB

Spring
JIT (via OpenJDK)
576 MB

Quarkus
Native (via GraalVM)
76 MB

Spring
Native (via GraalVM)
205 MB

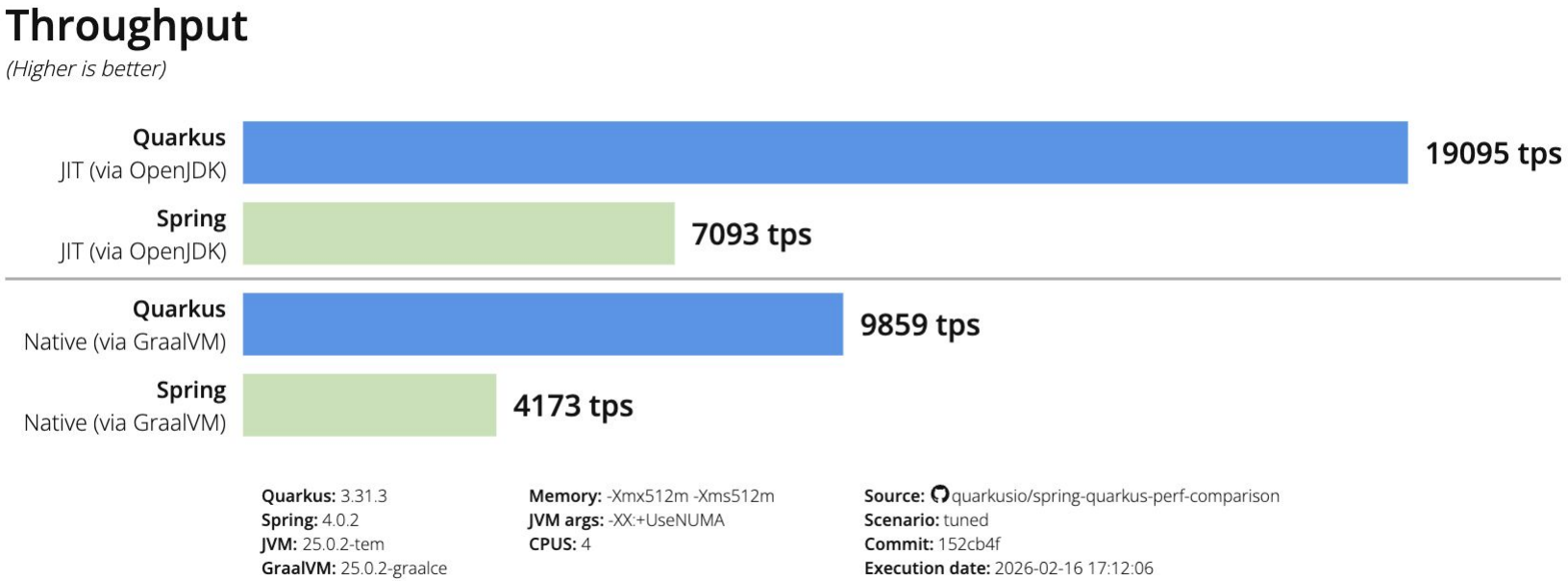
Quarkus: 3.31.3
Spring: 4.0.2
JVM: 25.0.2-tem
GraalVM: 25.0.2-graalce

Memory: -Xmx512m -Xms512m
JVM args: -XX:+UseNUMA
CPUS: 4

Source: quarkusio/spring-quarkus-perf-comparison
Scenario: tuned
Commit: 152cb4f
Execution date: 2026-02-16 17:12:06

https://github.com/quarkusio/benchmarks

Quarkus offers unequaled performance III



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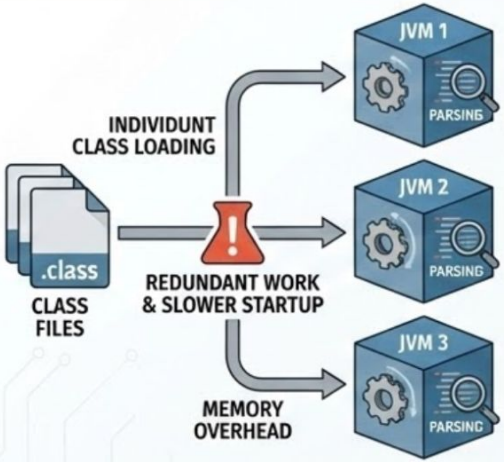
CDS – Class Data Sharing

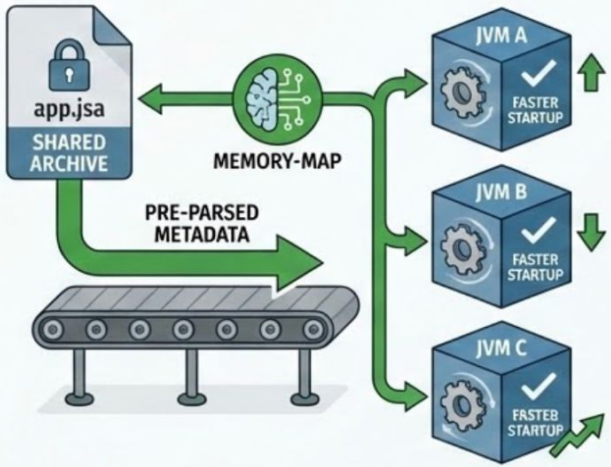
Optimizing Java Startup for Typical Applications

THE PROBLEM: Slow Individual Class Loading



- Traditional Java apps parse class data individually at startup.
- Leads to redundant work and slower initialization.
- Significant memory overhead for each JVM instance.

THE SOLUTION: Class Data Sharing (CDS)



- Preloads class metadata into a shared, memory-mapped archive.
- JVMs skip parsing, enabling much faster startup.
- Reduces memory footprint by sharing read-only data.
- Works seamlessly with OpenJDK and containers.

IMPLEMENTATION: How to Use CDS

1. Create Shared Archive

```
>
-XX:ArchiveClassesAtExit=app.jsa
```

Run application once to generate the shared archive file during exit.

2. Use Shared Archive

```
>
-XX:SharedArchiveFile=app.jsa
```

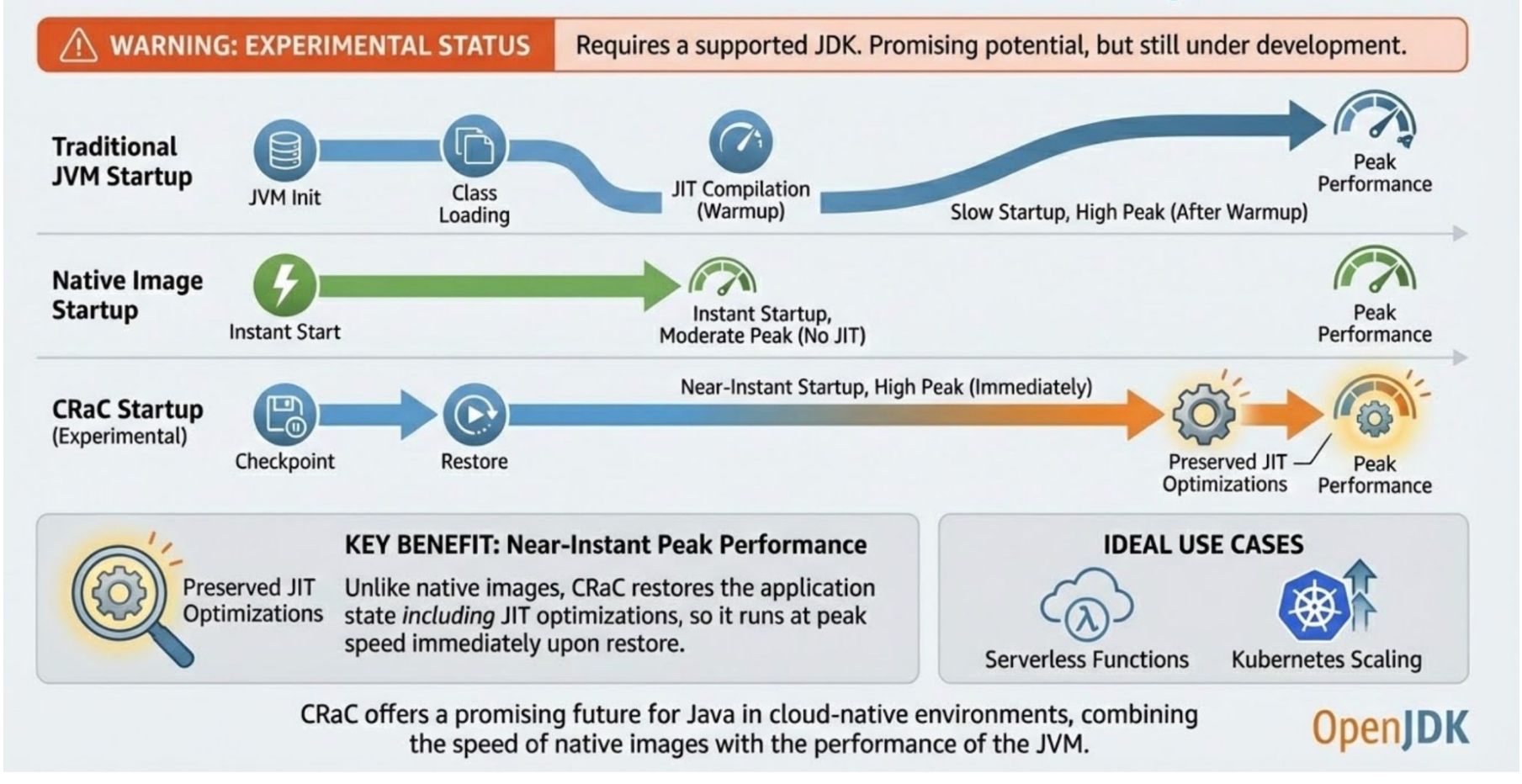
Start JVMs using the pre-processed, memory-mapped data.

Feature	Traditional	CDS
Class Parsing	Individual	Pre-parsed
Startup Time	Slower	Faster
Memory Usage	Higher	Lower

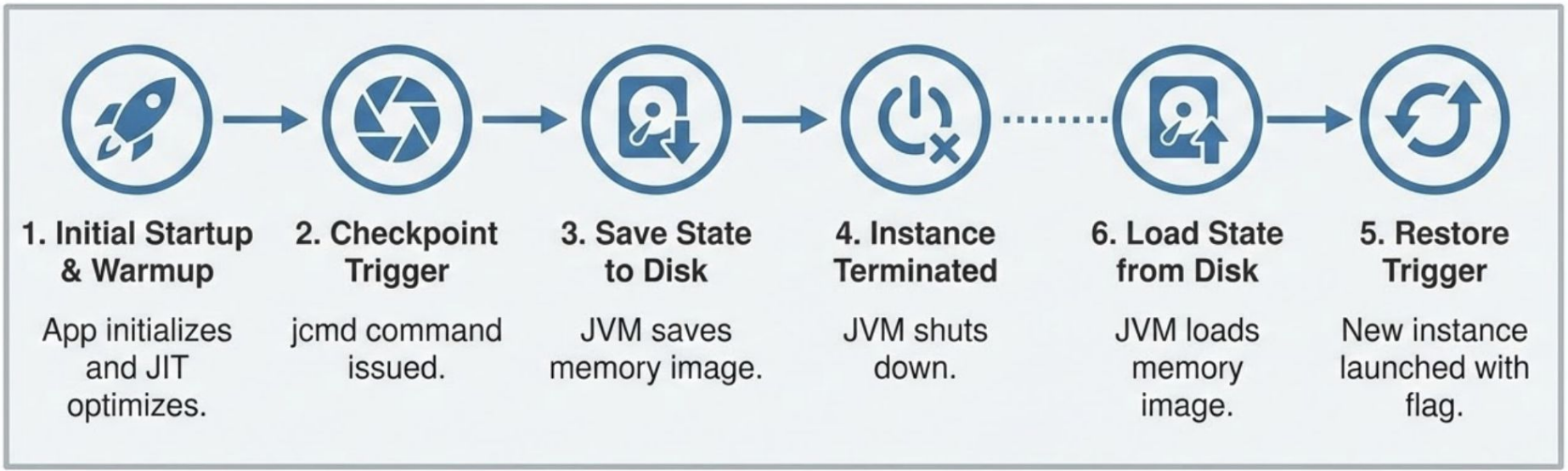
OpenJDK

https://openjdk.org/jeps/310

CRaC – Coordinated Restore at Checkpoint



CRaC – Coordinated Restore at Checkpoint

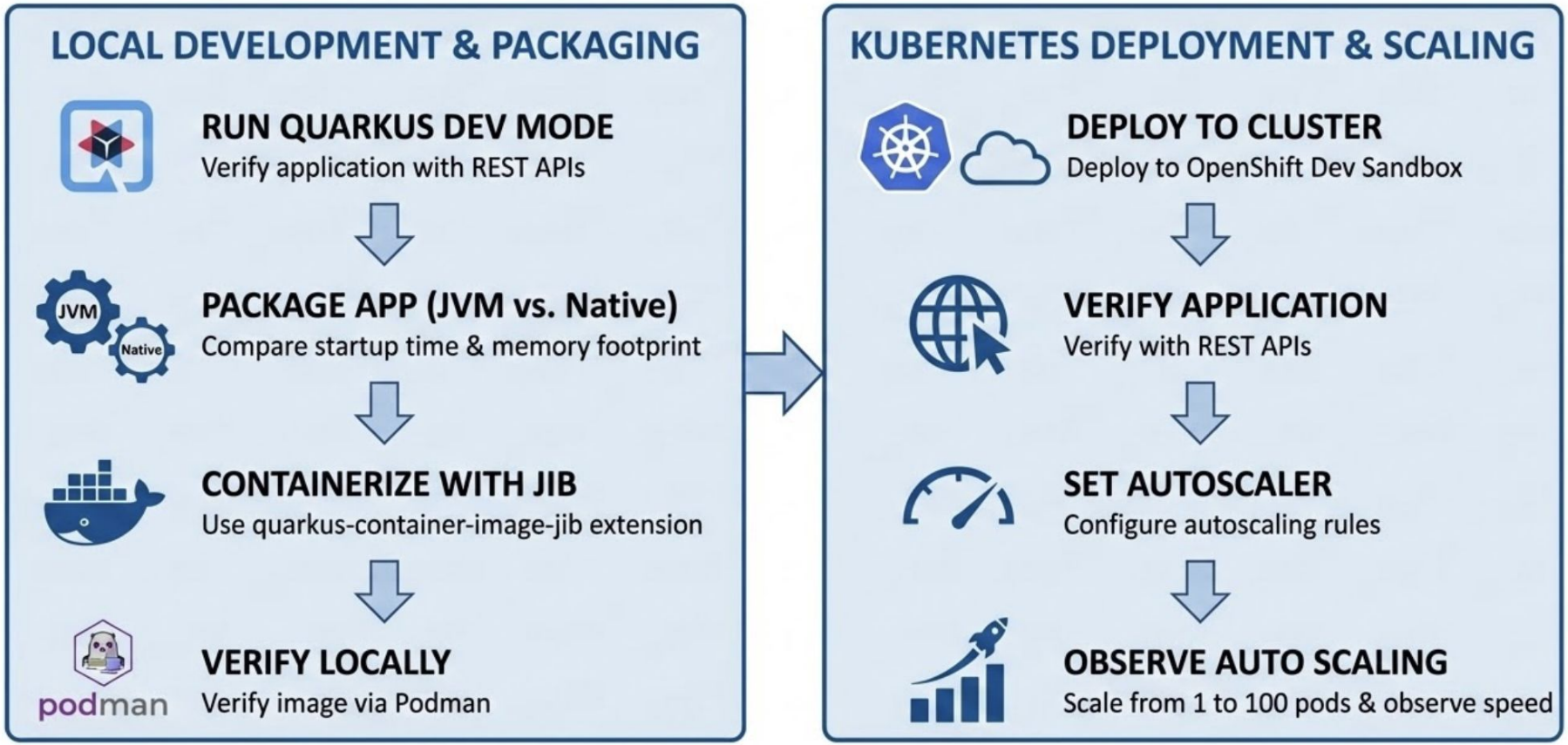


OpenJDK

DEMO

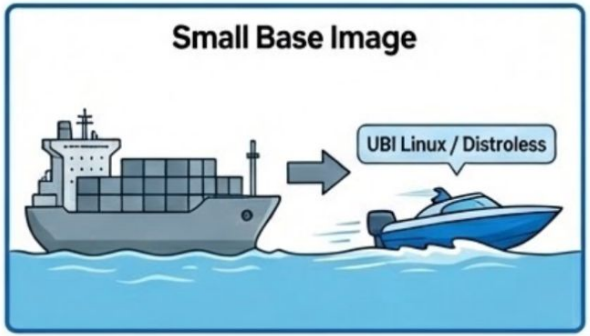
Speed up Kube Native Java Development

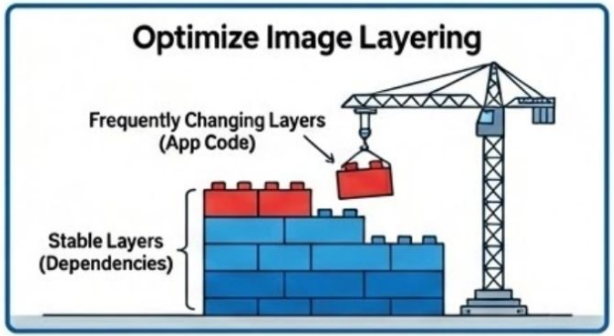
Demo Scenario

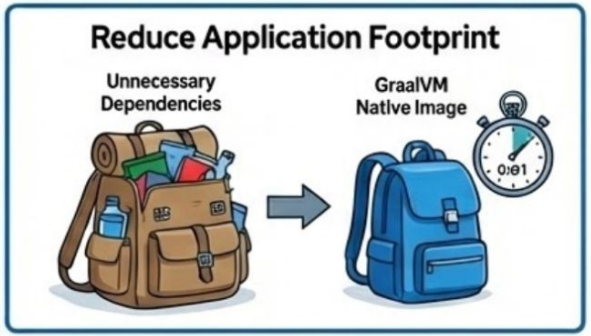


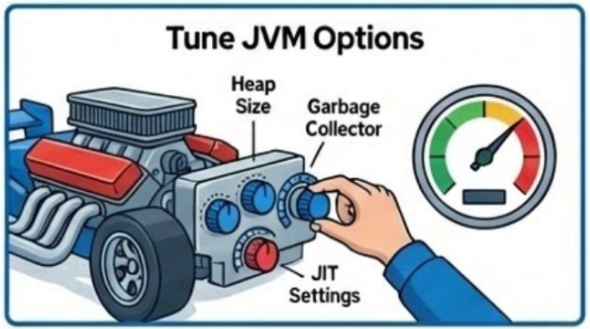
https://github.com/danieloh30/high-perf-kube-java.git

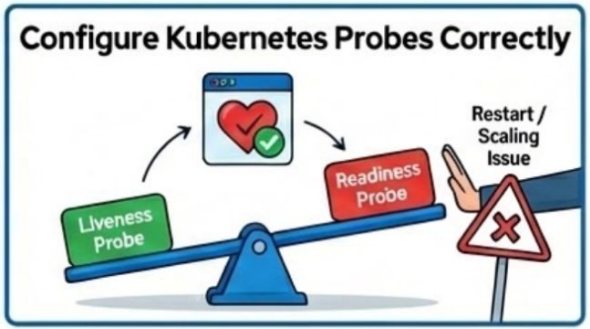
Practical tuning: Reducing Startup Time



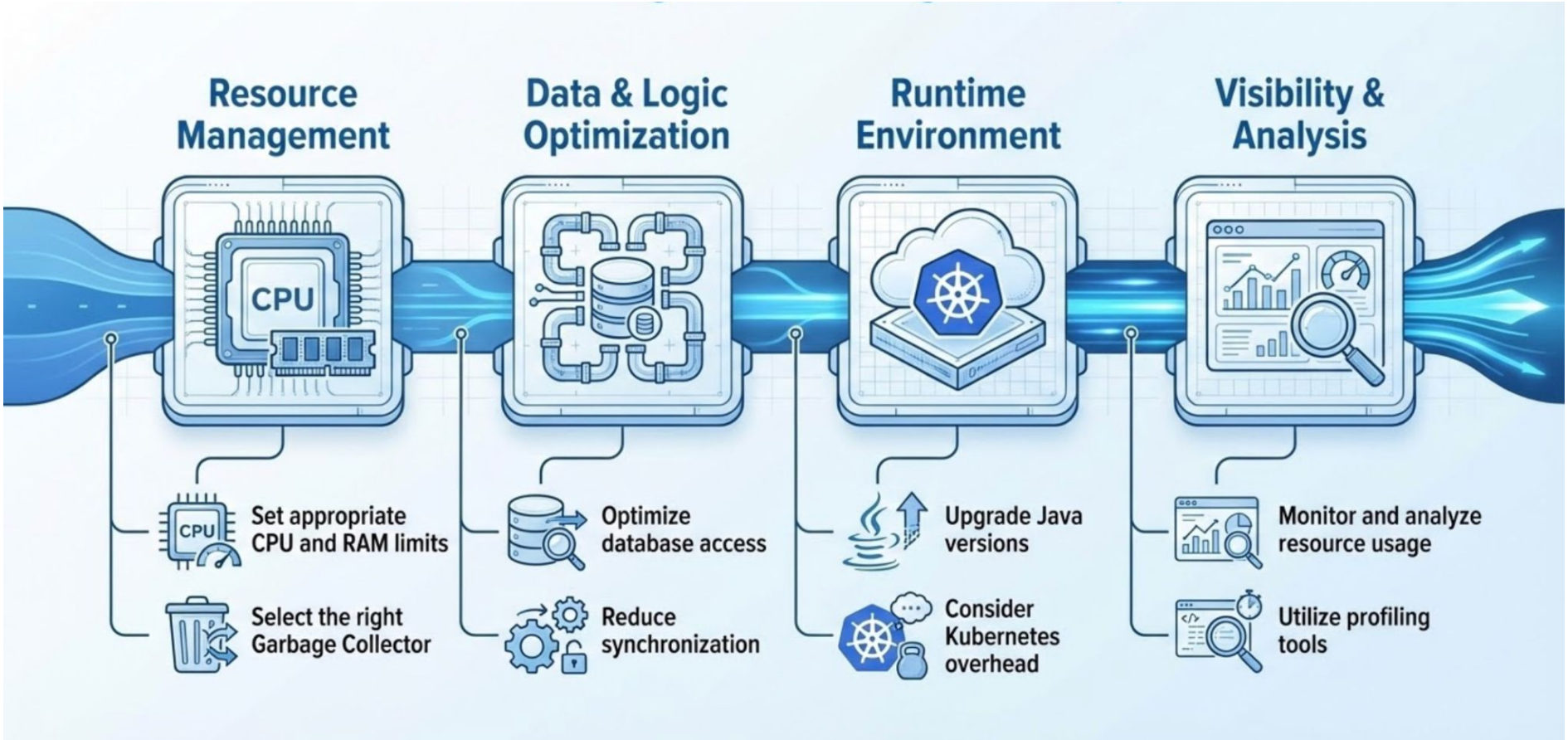








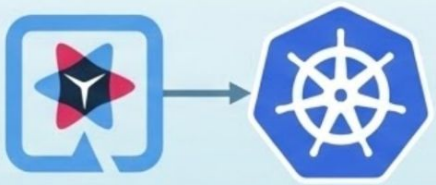
Practical tuning: Enhancing Container Efficiency



Key Takeaways

Java can be Kubernetes-friendly

Demo showed measurable improvements



Quarkus + Kubernetes (OpenShift) allows you to put all tools together natively

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